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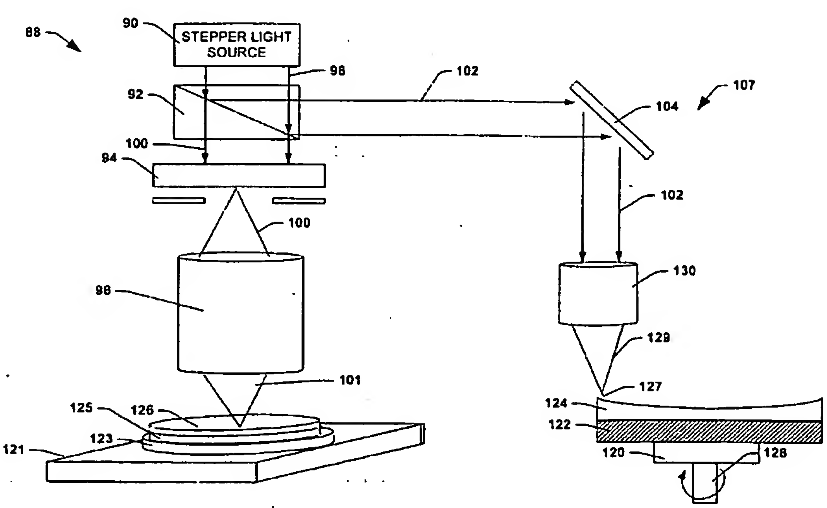

(57) Abstract: A system and method of developing an advanced lithography system is provided. The system can perform edge bead removal operations utilizing an optical edge bead removal system (107) and perform patterning operations with a stepper system (88) utilizing a single light source (90). Preferably, the light source is an excimer laser and a beam splitter (92) allows for transmission of the light in a first direction (100) to the stepper system (88) and in a second direction (102) to the optical edge bead removal system or EBR system (107). In an alternate aspect of the invention, a reflective enclosure (180) is provided for transmitting light (184) in the first and second directions.

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LITHOGRAPHY SYSTEM WITH DEVICE FOR EXPOSING THE PERIPHERY OF A WAFER

TECHNICAL FIELD

The present invention generally relates to semiconductor devices and processes, and in particular to a stepping system and edge bead removal system that utilize a single light source.

BACKGROUND ART

In the semiconductor industry, there is a continuing trend toward higher device densities. To achieve these high densities there has been and continues to be efforts toward scaling down device dimensions (*e.g.*, at submicron levels) on semiconductor wafers. In order to accomplish such high device packing density, smaller and smaller features sizes are required. This may include the width and spacing of interconnecting lines, spacing and diameter of contact holes, and the surface geometry such as corners and edges of various features.

The requirement of small features with close spacing between adjacent features requires high resolution photolithographic processes. In general, lithography refers to processes for pattern transfer between various media. It is a technique used for integrated circuit fabrication in which a silicon structure is coated uniformly with a radiation-sensitive film, the resist, and an exposing source (such as optical light, x-rays, or an electron beam) illuminates selected areas of the surface through an intervening master template, the mask, for a particular pattern. The lithographic coating is generally a radiation-sensitive coating suitable for receiving a projected image of the subject pattern. Once the image is projected, it is indelibly formed in the coating. The projected image may be either a negative or a positive image of the subject pattern. Exposure of the coating through a photomask causes the image area to become either more or less soluble (depending on the coating) in a particular solvent developer. The more soluble areas are removed in the developing process to leave the pattern image in the coating as less soluble polymer.

Due to the extremely fine patterns which are exposed on the photoresist material, thickness uniformity of the photoresist material is a significant factor in achieving desired critical dimensions. The photoresist material should be applied such that a uniform thickness is maintained in order to ensure uniformity and quality of the photoresist material layer. The photoresist material layer thickness typically is in the range of 0.1 to 3.0 microns. Good resist thickness control is highly desired, and typically variances in thickness should be less than ± 10-20Å across the wafer. Very slight variations in the photoresist material thickness may greatly affect the end result after the photoresist material is exposed by radiation and the exposed portions removed.

Application of the resist onto the wafer is typically accomplished by using a spin coater. The spin coater is essentially a vacuum chuck rotated by a motor. The wafer is vacuum held onto the spin chuck. Typically, a nozzle supplies a predetermined amount of resist to a center area of the wafer. The wafer is then accelerated to and rotated at a certain speed, and centrifugal forces exerted on the resist cause the resist to disperse over the whole surface of the wafer. The resist thickness obtained from a spin coating

process is dependent on the viscosity of the resist material, spin speed, the temperature of the resist and the temperature of the wafer.

After the photoresist is spin coated onto the wafer, a rim or bead of photoresist remains on the edge of the wafer. Fig. 1a illustrates this type of problem in applying a photoresist layer to a wafer. A nozzle 10 applies a resist layer 12 on a central area of a wafer 14. The wafer 14 is vacuum held onto a rotating chuck 16 driven by a shaft 18 coupled to a motor 20. The wafer 14 is rotated at a constant speed and the resist flows covering the entire top surface of the wafer. After the photoresist 12 is spin coated onto the wafer 14, a rim or bead 22 of photoresist 12 remains on the edge of the wafer 14. This rim or bead 22 is removed by utilizing an edge bead removal system. In certain applications this system includes applying an edge bead removal solvent by using an edge bead removal (EBR) nozzle, so that loose particles from the rim or bead do not become a source of contamination that can cause wafer defects. Typically, the solvent is either applied at the bottom edge of the wafer, while the wafer is spun causing the solvent to wick around the edge and wash off the photoresist bead or the solvent is applied on the top outside edge of the wafer. However, applying the solvent to the top edge of the wafer has its own inherent problems. One of the problems is that when the solvent spray or jet is shut off, a drop of solvent can remain in a nozzle tip of the nozzle, and may free fall onto the wafer undesirably dissolving useful portions of the photoresist material layer, thus destroying the uniformity of the wafer ultimately causing wafer defects.

Another system for removing an edge bead on a wafer that alleviates the problem of solvent use is known as an optical edge bead removal module (EBR) installed in a track system such as the family of CLEAN TRACK® systems manufactured by Tokyo Electron Limited, Inc. in Tokyo, Japan. Such EBR modules are used in the various modes of photoresist processing. A portion of such an edge-bead removal system 28 is illustrated in Fig. 1b. The system includes an EBR module light source 30 and a focusing lens 34. The focusing lens 34 is used for controlling the distribution of light from the light source 30, by focusing the light into a spot at a location corresponding to the peripheral portion of bead 22 of the photoresist layer 12 on the wafer 14 by light rays 32. Alternatively as illustrated in Fig. 1c, the lens 34 may be replaced with a generally disk-shaped shield 38 which is smaller than the size of the wafer 14 and therefore allows for the exposure of the peripheral portion 22 of the wafer 14 by light rays 36. The size of the shield 38 is generally tunable to thereby allow the peripheral portion of the photoresist 12 to be adjustably exposed. The wafer 14 can be exposed on the rotating chuck 16 or placed on a wafer holder 17 as illustrated in Fig. 1c. An exemplary wafer after edge bead removal is illustrated in prior art Fig. 1d. Use of the edge-bead removal unit 28 allows for the selective exposure of the photoresist layer without a masking step and without use of the stepper. Consequently, during the selective exposure process, the stepper can be used for other processing tasks, thereby advantageously increasing the stepper throughput.

Fig. 1e illustrates a representative stepper system 58 for wafer alignment during the step of patterning the photoresist layer with a desired circuit pattern. The system 58 includes a reticle 66 with the

design pattern 64. A stepper light source 60 projects light 62 through the reticle 66 to so as to project the design pattern 64 onto a portion of the wafer 14. The light 62 from the stepper light source 60 passes through the reticle 66 and through the optical axis of a projection lens system 68. The projection lens system 68 projects the design pattern 64 of the reticle 66 onto the wafer 14 while in most cases substantially reducing the imaged design pattern. Typically, a wafer holder 72 vacuum-holds the wafer 14 and is provided for slight rotation relative to a stage 74 two-dimensionally moveable in x-direction and y-direction. The stage 74 and wafer holder 72 are controlled by a controller 80. The controller 76 effects rotation of the wafer holder 72 and movement of the stage 76 (*via* a plurality of motors (not shown)) for wafer alignment and positioning. The controller 80 includes a processor 76 which is programmed to control and operate the various components within the system 58 in order to carry out various functions. A memory 78 which is operatively coupled to the processor 76 can also be included in the controller 80 and serves to store program code executed by the processor 76 for carrying out operating functions of the system 58.

Conventionally, the optical edge bead systems utilize a mercury arc lamp to provide an exposure light source having a wavelength in the ultraviolet range. As feature sizes continue to decrease, however, wavelengths in the deep ultraviolet range are necessary, for example, at wavelengths including 248 nm (KrF), 193nm (ArF) and 153nm (F_2). At such wavelengths, arc lamps do not have sufficient fluence (not enough energy or photons). An excimer laser light source is thus usually needed. A separate excimer laser source is used in the stepper system. These excimer laser light sources at the above ultraviolet wavelengths are extremely expensive.

In view of the above, a system and method that utilizes a single light source for both systems would generate significant cost savings and permit EBR at deep UV wavelengths, and would thus be desirable.

DISCLOSURE OF INVENTION

The present invention relates to a system and method of developing an advanced lithography system that can perform edge bead removal operations utilizing an optical edge bead removal system and perform patterning operations with a stepper system utilizing a single light source. Preferably, the light source is an excimer laser and a beam splitter allows for transmission of the light in a first direction to the stepper system and in a second direction to the optical edge bead removal system. In an alternate aspect of the invention, a reflective enclosure is provided for transmitting light in the first and second directions.

In another aspect of the invention, the light source can transmit light in one direction for use by the stepper system and alternatively in another direction for use by the EBR system. This can be accomplished utilizing a movable reflector or mirror that moves from a rest position allowing the light to be transmitted to the stepper system and to a reflective position allowing light to be transmitted to the EBR system. This can also be accomplished by a round rotatable reflector that surrounds the light source. The

rotatable reflector moves from a first position transmitting the light to the stepper system and to a second position transmitting light to the EBR system

One particular aspect of the invention relates to an advanced lithography system for exposure of a photoresist material layer on a semiconductor wafer. The system includes a light system operable to transmit a beam of light in a first and a second direction simultaneously. A stepper system is provided that is adapted to receive and utilize the beam of light from the first direction in patterning operations and a EBR system is provided that is adapted to receive and utilize the beam of light from the second direction in edge bead removal operations.

Another aspect of the present invention relates to an advanced lithography system for exposure of a photoresist material layer on a semiconductor wafer. The system includes a light system operable to transmit a beam of light in a first direction and alternatively in a second direction, a stepper system adapted to receive and utilize the beam of light from the first direction in patterning operations and a EBR system adapted to receive and utilize the beam of light from the second direction in edge bead removal operations.

Another aspect of the present invention relates to an advanced lithography system for exposure of a photoresist material layer on a semiconductor wafer including means for providing a beam of light in a first and a second direction simultaneously. The system further includes means for generating a patterning operation on the photoresist layer. The means for generating a patterning operation is adapted to receive and utilize the beam of light from the first direction. The system also includes means for performing edge bead removal operations. The means for performing edge bead removal operations is adapted to receive and utilize the beam of light from the second direction.

Yet another aspect of the present invention relates to a method for exposure of a photoresist material layer on a semiconductor wafer. The method includes the steps of providing a single light system operable to transmit a beam of light in a first and a second direction simultaneously from a single light source, transmitting the light in the first direction to a stepper system and transmitting light in the second direction to a EBR system and performing edge bead removal operations on a first semiconductor wafer with the EBR system, while simultaneously performing patterning operations on a second semiconductor wafer with the stepper system.

In yet another aspect of the invention a method for exposure of a photoresist material layer on a semiconductor wafer is provided. The method includes the steps of providing a single light system operable to transmit a beam of light in a first direction and alternatively in a second direction from a single light source, transmitting the light in the first direction to a EBR system and performing edge bead removal operations on a semiconductor wafer and transmitting the light in the second direction to a stepper system and performing patterning operations on another semiconductor wafer.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative embodiments of the invention. These

embodiments are indicative, however, of but a few of the various ways in which the principles of the invention may be employed. Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1a is representative schematic illustration of a photoresist material application system in accordance with the prior art;

Fig. 1b is representative schematic illustration of an optical edge bead removal system in accordance with the prior art;

Fig. 1c is a representative schematic illustration of an alternate optical edge bead removal system in accordance with the prior art;

Fig. 1d is a representative schematic illustration of an exemplary wafer after an edge bead removal operation;

Fig. 1e is a representative schematic illustration of a wafer alignment system in accordance with the prior art;

Fig. 2a illustrates a front view of an advanced lithography system in accordance with the present invention;

Fig. 2b is a plan view illustrating wafer edge exclusion using an EBR system in accordance with the present invention;

Fig. 2c is a plan view illustrating wafer edge exclusion using an EBR system in accordance with the present invention;

Fig. 3 illustrates a front view of an alternate advanced lithography system in accordance with the present invention;

Figs. 4a-4b illustrates a partial schematic representation of a lithography system utilizing a movable reflector in accordance with the present invention;

Figs. 5a-5b illustrates a partial schematic representation of a lithography system utilizing a rounded rotatable reflector in accordance with the present invention;

Figs. 6a-6b illustrates a partial schematic representation of another lithography system utilizing a light source that transmits alternatively in different directions in accordance with the present invention;

Fig. 6c illustrates a partial schematic illustration of the lithography system of Figs. 6a-6b utilizing a reflective enclosure in accordance with the present invention;

Fig. 7 is a flow diagram illustrating one specific methodology for carrying out the present invention; and

Fig. 8 is a flow diagram illustrating another specific methodology for carrying out the present invention.

MODE(S) FOR CARRYING OUT THE INVENTION

The present invention is now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. The present invention is described with reference to a stepper system and one or more edge bead removal systems that utilize a single light source. It should be understood that the description of these embodiments are merely illustrative and that they should not be taken in a limiting sense.

Referring initially to Fig. 2a, a stepper system 88 is provided that uses a light source 90 to produce light beam 98 directed to a beam splitter 92. Preferably, the light source is an excimer laser source, which provides wavelengths in the deep ultraviolet region, including 248 nm (KrF), 193nm (ArF) and 153nm(F_2). However, other light sources could be used and should be apparent to those skilled in the art. The beam splitter 92 directs a first light portion 100 of the light beam 98 to a reticle 94 in the stepper system 88. The reticle 98 is provided with a design pattern (not shown) that projects first light portion 100 onto a lens system 96 in the form of the design pattern. The projection lens system 96 projects the design pattern of the reticle 94 onto a photoresist layer 126 disposed on a wafer 125, while in most cases substantially reducing the imaged design pattern. Typically, a wafer holder 123 vacuum-holds the wafer 125 and is provided for slight rotation relative to a stage 121 two-dimensionally moveable in x-direction and y-direction. The stage 121 and the wafer holder 123 are controlled by a controller (not shown).

The beam splitter 92 also directs a second light portion 102 of the light beam 98 to a reflector 104 in an optical edge bead removal (EBR) system 107. The reflector 104 is preferably a mirror. The second light portion 102 is reflected by the reflector 104 to a second lens assembly 130 disposed over the edge of a second photoresist layer 124. The photoresist layer 124 is disposed on a wafer 122 vacuum held to a chuck 120. The chuck 120 is rotatable via a shaft 128. The photoresist layer 124 includes an edge bead 127 disposed around the peripheral portion of the photoresist layer 124. The edge bead 127 can be exposed by placing the EBR system 107 with the second lens assembly 130 over a fixed position at the peripheral portion of the photoresist layer 124, and focusing a focused light portion 129 onto the edge bead 127 at the fixed position, while rotating the photoresist layer 124 about the shaft 128.

An exemplary edge bead exposure provided by the EBR system 107 of Fig. 2a is illustrated in Fig. 2b, wherein the edge bead 127 is exposed substantially uniformly about a periphery of the wafer 122. Alternatively, the chuck 120 or the mirror 104 and lens assembly 130 may be moved as the wafer 122 rotates to vary the width of the edge bead 127 or form predetermined patterns such as one or more small arcs, as illustrated in Fig. 2c.

An alternate embodiment of the invention is illustrated in Fig. 3, where like parts are represented by like reference numerals. In the alternate aspect of the invention illustrated in Fig. 3, the stepper system is similar to the stepper system of Fig. 2a, while an EBR system 105 is provided different from that illustrated in Fig. 2a. The EBR system 105 includes the reflector 104 for reflecting the second

light portion 102. However, the reflector 104 transmits the second light portion 102 to a second reflector 106 located between the reflector 104 and a shield 110. The reflector 106 is utilized to control and distribute the second light portion 102 and not essential for the operation of the EBR system 105. The shield 110 prohibits the majority of the light portion 102 from reaching the photoresist layer 126 disposed on the wafer 125, but allows edge light portions 108 to exposed the peripheral edge of the photoresist layer 126.

The stage 121 supports the wafer 125 within the stepper system. Preferably, a transfer system (not shown) is provided to transfer the wafer 125 from the stepper stage 121 to a stage within the EBR system 105. Alternatively, as illustrated in Fig. 3, the stage 121 may be movable from a first position, below the EBR system 105 for removal of a peripheral portion of a photoresist layer 126 on the wafer 125, to a second position, below the stepper system 88 for pattern exposure of the remainder of the photoresist layer 126 on the wafer 125. It is to be appreciated that the wafer 125 can be moved between a stage of the EBR system 105 to a separate stage on the stepper system 88, such that simultaneous operation of both the stepper system 88 and the EBR system 105 can be performed on separate wafers in an assembly line type fashion.

In yet another embodiment of the invention, the light from a single light source may be directed toward the EBR system for removing the edge bead and then the single light source may be directed toward the stepper system during a different period of time for patterning designs in a photoresist layer. For example, Figs. 4a-4b illustrate utilizing a movable reflector 152 for accomplishing the foregoing end. Only a portion of the stepper system and the EBR system are shown for the sake of brevity and also to avoid redundancy. As can be seen in Fig. 4a, a stepper light source 150 is provided that transmits light portions 155 toward a reticle 154 of a stepper system. A second reflector 156 is disposed near a EBR system 158.

In Fig. 4a, the reflector 152 is in a first or rest position in which the stepper system utilizes the stepper light source 150, while the EBR system 158 remains dormant. Fig. 4b illustrates the reflector 152 in a second or reflective position. In the reflective position, the reflector 152 blocks the light portions 155 of the stepper light source 150 from being transmitted to the stepper system, while reflecting the light portions 155 to the second reflector 156, which in turn reflects the light to the EBR system 158. When the reflector 152 is in its second position, the EBR system utilizes the stepper light source 150, while the stepper system remains dormant. It is to be appreciated that the reflector may be movable in any of a translational or rotational position for movement between its first and second positions.

Figs. 5a-5b illustrate utilizing a rounded rotatable reflector 180 that surrounds a light source 182 for accomplishing the foregoing end. Again, only a portion of the stepper system and the EBR system are shown for the sake of brevity and also to avoid redundancy. As can be seen in Fig. 5a, the light source 182 is provided that transmits light portions 184 toward a reticle 186 of a stepper system. A

second reflector 188 is disposed near a EBR system 190. The reflector 180 is in a first position in which the stepper system utilizes the stepper light source 182, while the EBR system 190 remains dormant. Fig. 5b illustrates the reflector 180 in a second position. In the second position, the reflector 180 reflects the light portions 184 to the second reflector 188, which in turn reflects the light to the EBR system 190. When the reflector 180 is in its second position, the EBR system 190 utilizes the light source, while the stepper system remains dormant.

Figs. 6a-6c illustrate yet another embodiment of the invention. Again, only a portion of the stepper system and the EBR system are shown for the sake of brevity and also to avoid redundancy. Referring initially to Fig. 6a, the light source 210 is provided that transmits light portions 212 in a first direction toward a reticle 214 of a stepper system. The light source 210 can also transmit light portions 220 in a second direction toward a reflector 216 and ultimately to a EBR system 218, as illustrated in Fig. 6b. It is appreciated that the light source 210 can transmit light portions 212 and 220 in different directions in a variety of manners. For example, the light source 210 may be rotatable or the light source 210 or the light portions 212 or 220 may be enveloped in a reflective enclosure including closable apertures for allowing light portions 212 and 220 to travel in different directions, as illustrated in Fig. 6c. In the latter case, the light source 210 transmits light to a reflective enclosure 211 which can transmit light portions 212 to the stepper system, while simultaneously transmit light portions 220 to the EBR system as illustrated in Fig. 6c.

It is to be appreciated that although the invention has been described with reference to utilizing the stepper light source as the single light source, the EBR light source could be utilized or any stand alone light source separate from the stepper system and the EBR system. It is further to be appreciated that the movement of the light portions, the EBR system and the stepper system can be facilitated utilizing a microprocessor, programming of which would be known to those skilled in the art.

Fig. 7 is a flow diagram illustrating one particular methodology for carrying out the present invention utilizing a wafer exposure system with only the EBR system or the stepper system operating at one time. In step 240, a photoresist layer is applied to a wafer substrate and spincoated onto the wafer forming an edge bead. In step 250, the exposure system transmits light from a light source to the EBR system. In step 260, the outer peripheral portion of the photoresist material layer is exposed and developed. In step 270, the outer peripheral portion of the photoresist material layer is removed. In step 280, the exposure system transmits light from the light source to the stepper system. In step 290, the stepper system exposes a pattern on a particular area of the wafer. In step 300, the stepper system moves the wafer to N additional positions, so that the pattern can be generated at the additional positions until the complete wafer is patterned. The process can then be repeated for the next wafer.

Fig. 8 is a flow diagram illustrating one particular methodology for carrying out the present invention utilizing a wafer exposure system with both the EBR system and the stepper system operating at one time. In step 330, a photoresist layer is applied to K wafer substrates and spincoated onto each of

the wafers forming edge beads. In step 340, the exposure system transmits light from a light source to both the EBR system and the stepper system. In step 350, the outer peripheral portion of the photoresist material layer of a first wafer is exposed and developed by the EBR system. In step 360, the outer peripheral portion of the photoresist material layer is removed for the first wafer. The EBR system is then moved to or receives N new wafers and the develop and removal process is repeated for each wafer in step 370. At the same time steps 350-370 are being performed, the stepper system develops a pattern on a particular area of a second wafer in step 355. In step 365, the stepper system moves the wafer to M additional positions, so that the pattern can be formed at the additional positions until the complete wafer is patterned. In step 375, the stepper system is moved to J new wafers or receives J new wafers and forms circuit patterns for M positions and repeats formation of circuit patterns for J new wafers.

Although the invention has been shown and described with respect to a certain preferred embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described components (assemblies, devices, circuits, etc.), the terms (including a reference to a "means") used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (*i.e.*, that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiments of the invention. In addition, while a particular feature of the invention may have been disclosed with respect to only one of several embodiments, such feature may be combined with one or more other features of the other embodiments as may be desired and advantageous for any given or particular application. Furthermore, to the extent that the term "includes" is used in either the detailed description and the claims, such term is intended to be inclusive in a manner similar to the term "comprising."

INDUSTRIAL APPLICABILITY

The apparatus and associated method may be used in the field of semiconductor processing for edge bead removal in stepper and track systems.

What is claimed is:

1. An advanced lithography system for exposure and development of a photoresist material layer (124, 126) on a semiconductor wafer (122, 125), the system comprising:

a light system (90, 92, 98) operable to transmit a beam of light (100, 102) in a first and a second direction simultaneously;

a stepper system (88) adapted to receive and utilize the beam of light (100) from the first direction in patterning operations; and

a EBR system (107) adapted to receive and utilize the beam of light (102) from the second direction in edge bead removal operations.

2. The system of claim 1, wherein the light system (90, 92, 98) comprises:

a beam splitter (92) that receives a beam of light (98) from a light source (90) and sends a first portion of the beam of light (100) in the first direction and sends a second portion of the beam of light (102) in the second direction; and

a reflector (104) adapted to receive the second portion of the beam of light (102) and transmit it to the EBR system (107).

3. The system of claim 2, wherein the EBR system (107) comprises an adjustable shield (110) adapted to be disposed above the photoresist layer (126) of the semiconductor wafer (125), the adjustable shield (110) allowing light (108) from the second light portion (102) to contact an outer peripheral portion of the photoresist layer (126).

4. The system of claim 2, wherein the EBR system (107) comprises:

a lens assembly (130) adapted to be disposed above an outer peripheral portion of the photoresist layer (124) of the semiconductor wafer, the lens assembly (130) focusing light (129) from the second light portion (102) to a point on the outer peripheral portion of the photoresist layer (124), such that a rotation of the semiconductor wafer (122) results in exposure of the outer peripheral portion of the photoresist layer (124), and

wherein the lens assembly (130) is operable to move the focusing light (129) from the second portion in a predetermined manner, thereby allowing a width of the outer peripheral portion of the photoresist layer (124) to vary or alter a shape of at least a portion of the outer peripheral portion of the photoresist layer (124).

5. An advanced lithography system for exposure and development of a photoresist material layer (124, 126) on a semiconductor wafer (122, 125), the system comprising:

a light system (150, 152) operable to transmit a beam of light (155) in a first direction and alternatively in a second direction;

a stepper system (88) adapted to receive and utilize the beam of light (155) from the first direction in patterning operations; and

a EBR system (107) adapted to receive and utilize the beam of light (155) from the second direction in edge bead removal operations.

6. The system of claim 5, further comprising:

a movable reflector (152) adapted to move between a rest position, allowing the light system to transmit the beam of light (155) in the first direction, and a reflective position, causing the beam of light (155) to transmit in the second direction; and

a second reflector (156) adapted to receive the beam of light (155) from the second direction and transmit it to the EBR system (107).

7. The system of claim 6, wherein the EBR system (107) comprises an adjustable shield (110) adapted to be disposed above the photoresist layer (124) of the semiconductor wafer (125), the adjustable shield (110) allowing light (155) received from the second reflector to contact an outer peripheral portion of the photoresist layer (124).

8. The system of claim 6, wherein the EBR system (107) comprises:

a lens assembly (130) adapted to be disposed above an outer peripheral portion of the photoresist layer (124) of the semiconductor wafer, the lens assembly (130) focusing light (129) received from the second reflector (156) to a point on the outer peripheral portion of the photoresist layer (124), such that spinning of the semiconductor wafer results in exposure of the outer peripheral portion of the photoresist layer (124), and

wherein the lens assembly (130) is operable to move the focusing light (129) from the second portion in a predetermined manner, thereby allowing a width of the outer peripheral portion of the photoresist layer (124) to vary or alter a shape of at least a portion of the outer peripheral portion of the photoresist layer (124).

9. The system of claim 5, further comprising a rotatable light source (180, 182) adapted to move between a first position transmitting light in the first direction to a second position transmitting light in the second direction.

10. A method for exposure and development of a photoresist material layer on a semiconductor wafer, the method comprising the steps of:

providing a single light system operable to transmit a beam of light in a first direction and a second direction from a single light source;

transmitting (280, 340) the light in the first direction to a stepper system (88) and transmitting (250, 340) light in the second direction to a EBR system (107); and

performing edge bead removal operations (300, 360) on a first semiconductor wafer (122) with the EBR system (107), while performing patterning operations (355) on a second semiconductor wafer (125) with the stepper system (88).

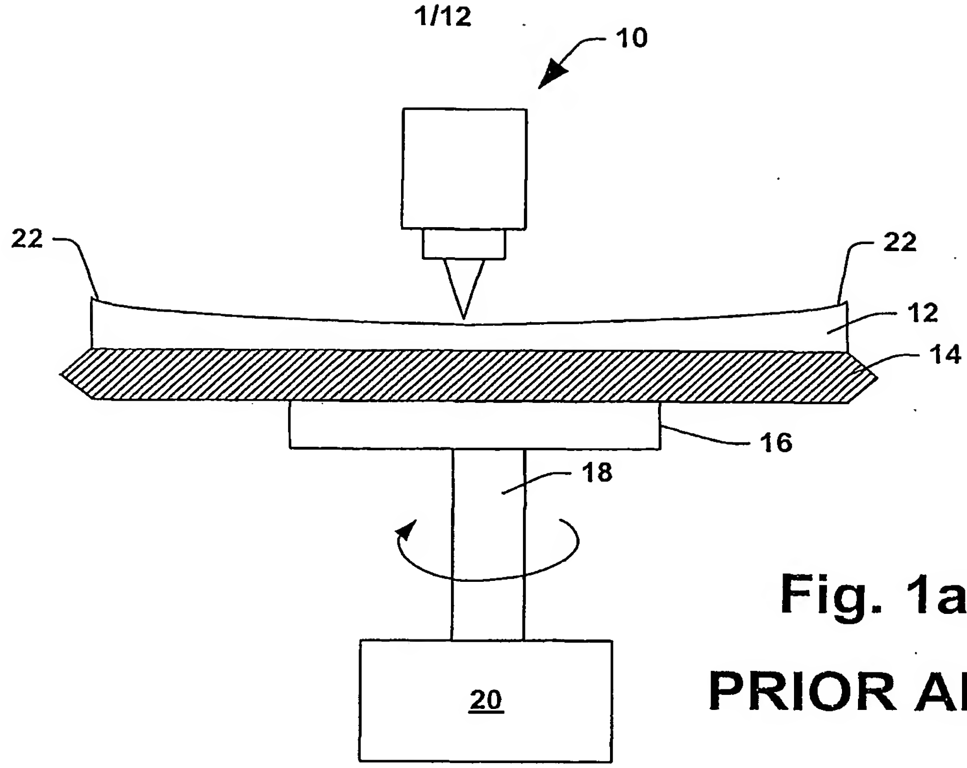


Fig. 1a
PRIOR ART

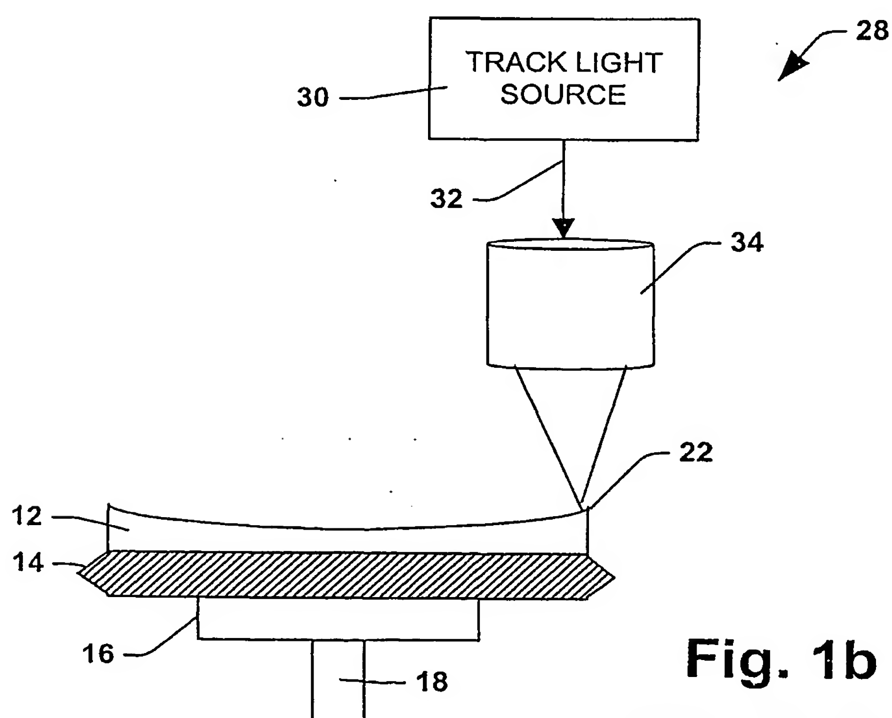


Fig. 1b
PRIOR ART

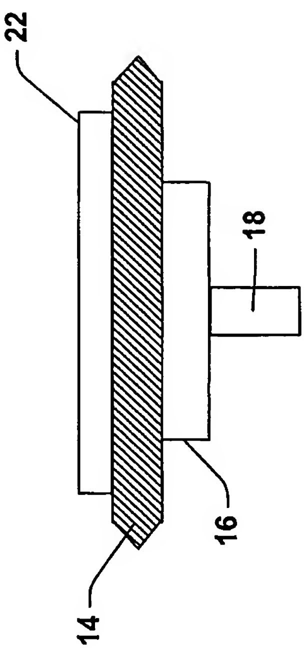


Fig. 1d
PRIOR ART

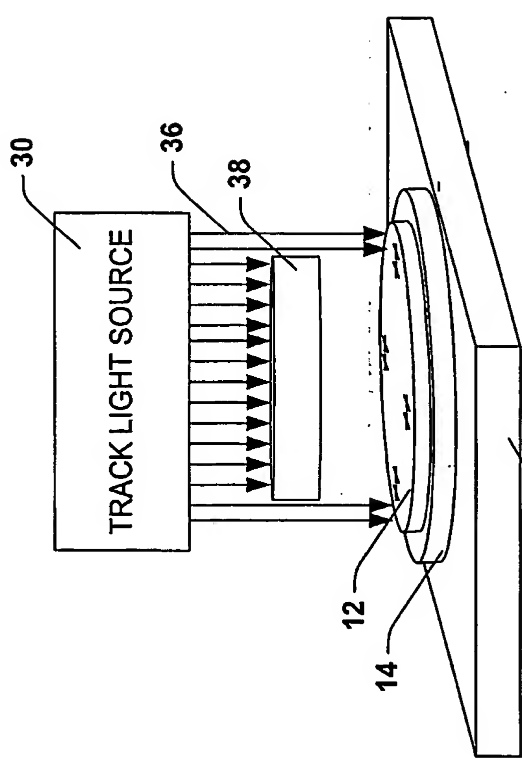


Fig. 1c
PRIOR ART

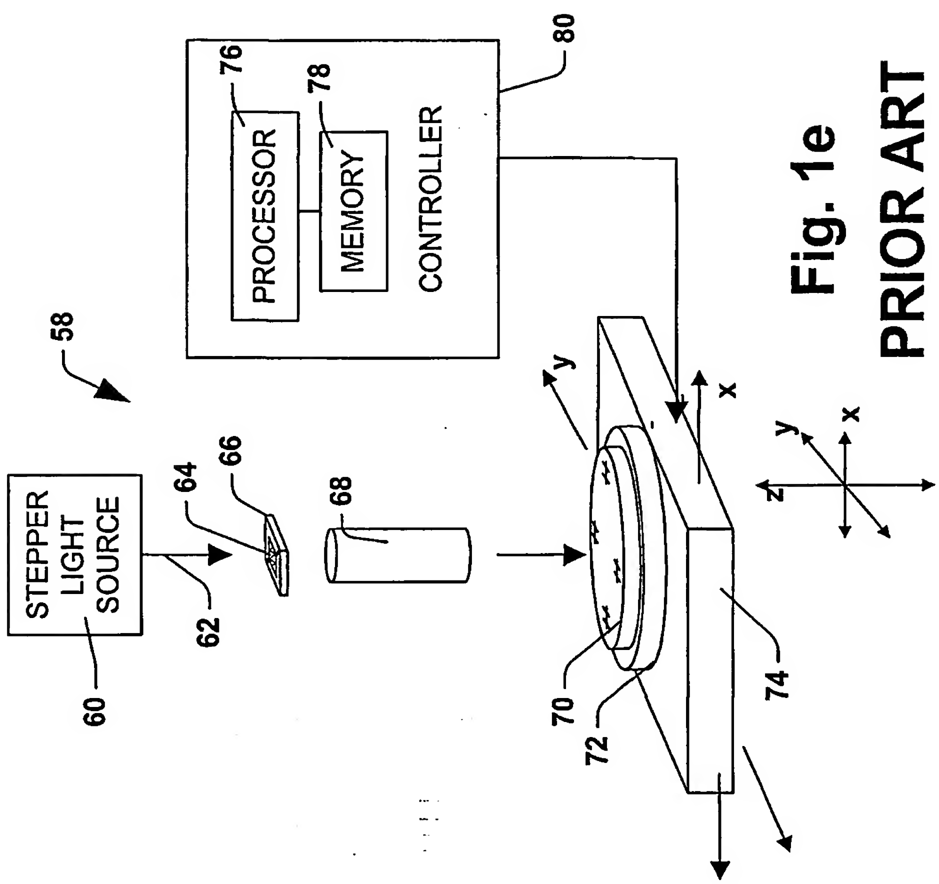
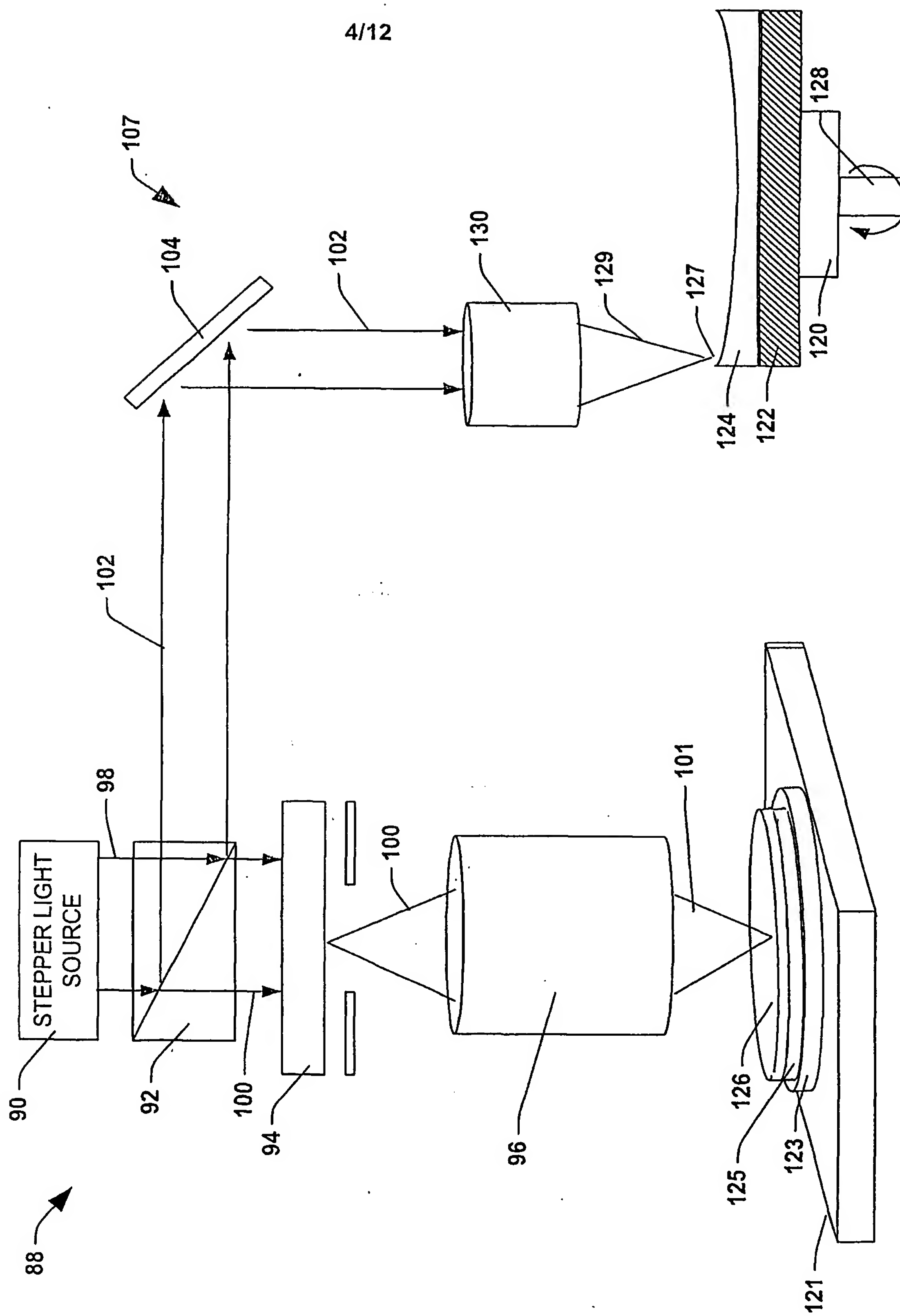


Fig. 1e
PRIOR ART


STEPPER LIGHT SOURCE
88
90
92
94
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98
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101
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126
127
128
129
130

Fig. 2a

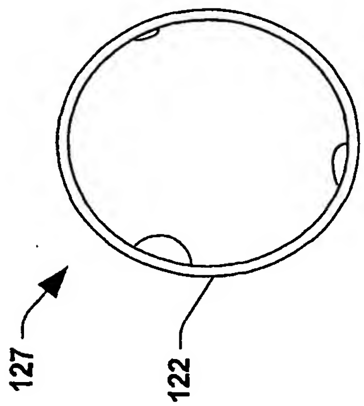


Fig. 2c

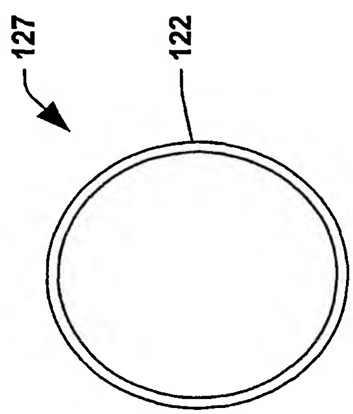
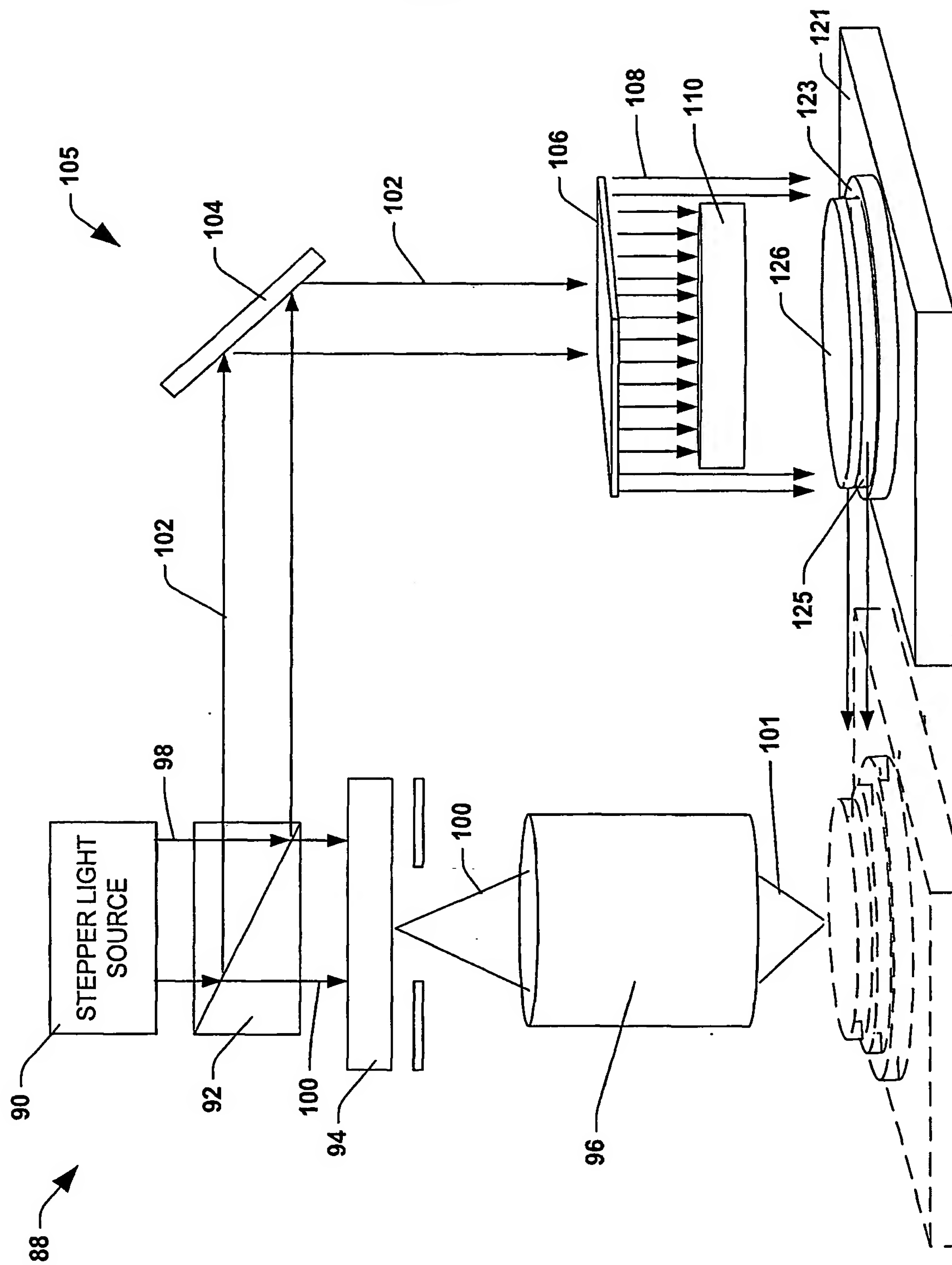


Fig. 2b


STEPPER LIGHT SOURCE
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101
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106
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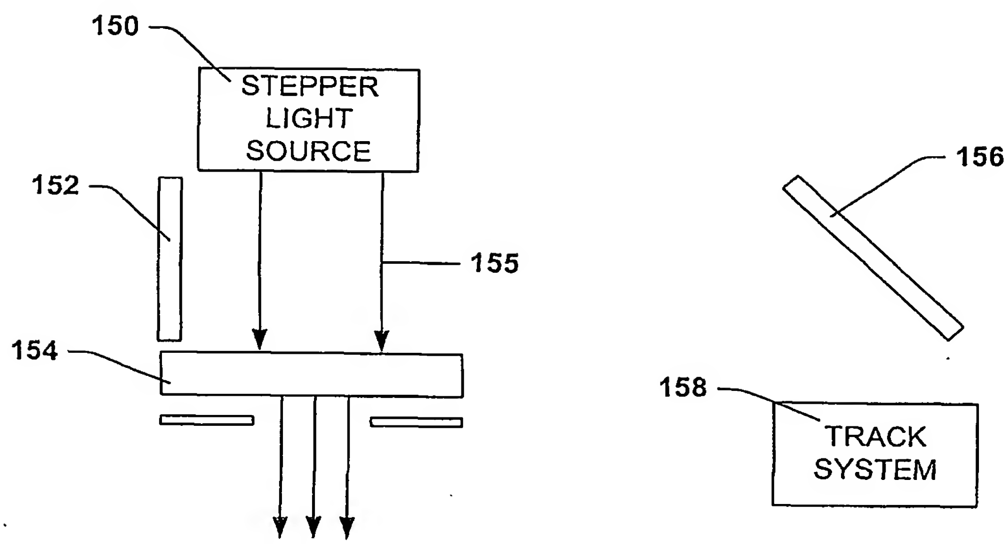
110
121
123
125
126

Fig. 3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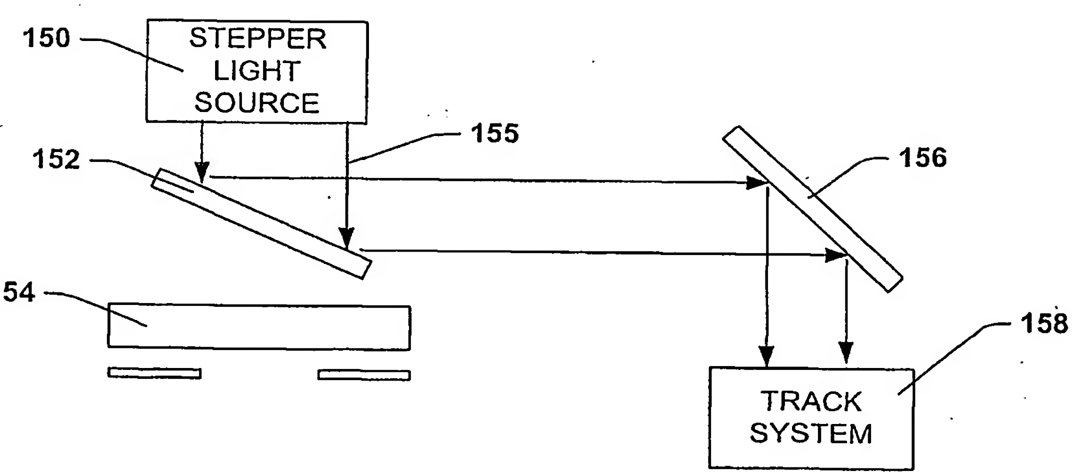
STEPPER LIGHT SOURCE
152
155
154
156
158
TRACK SYSTEM

Fig. 4a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STEPPER LIGHT SOURCE
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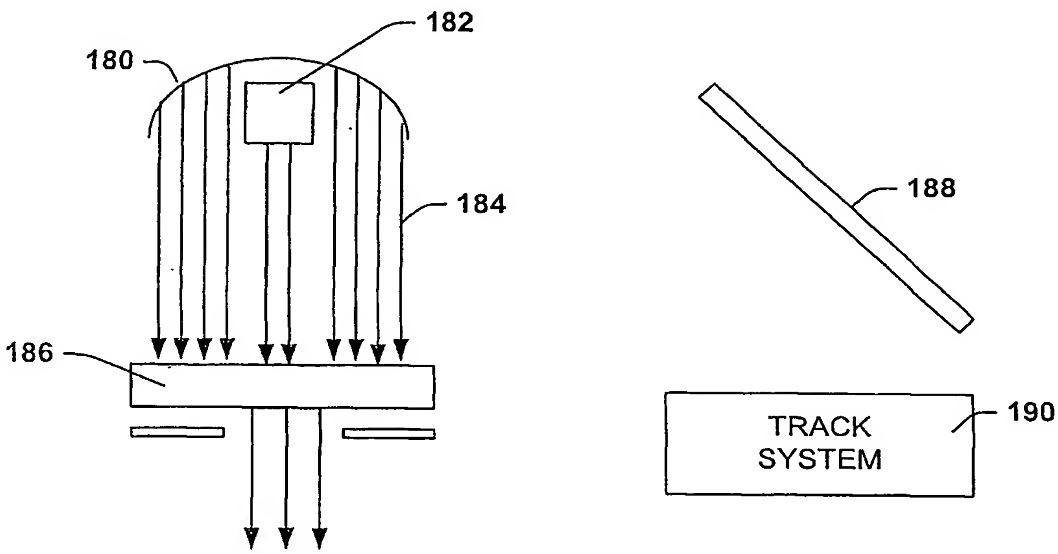
158
TRACK SYSTEM

Fig. 4b


182
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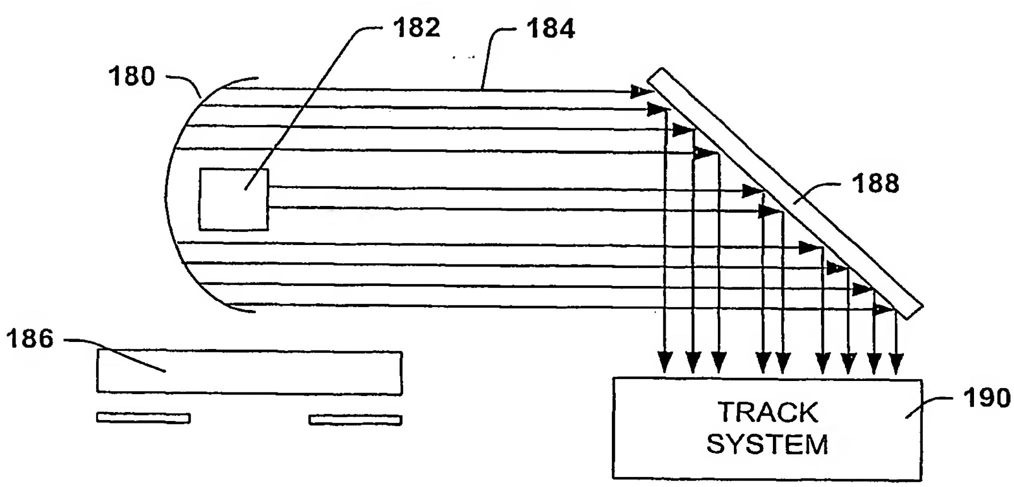
188
184
186
TRACK
SYSTEM
190

Fig. 5a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186
TRACK
SYSTEM
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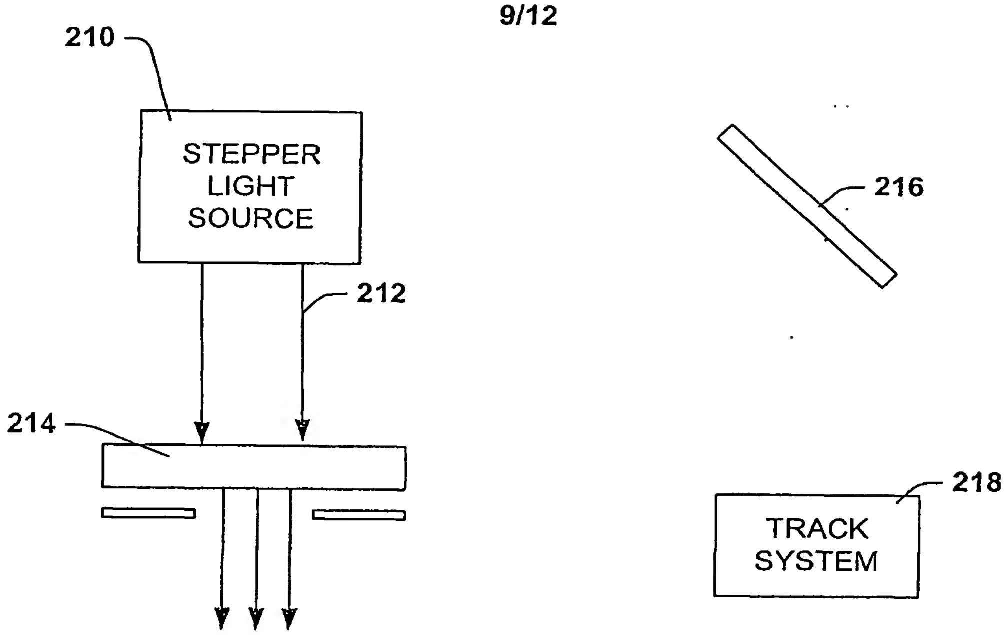
Fig. 5b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STEPPER
LIGHT
SOURCE
212
214
216
218
TRACK
SYSTEM

Fig. 6a

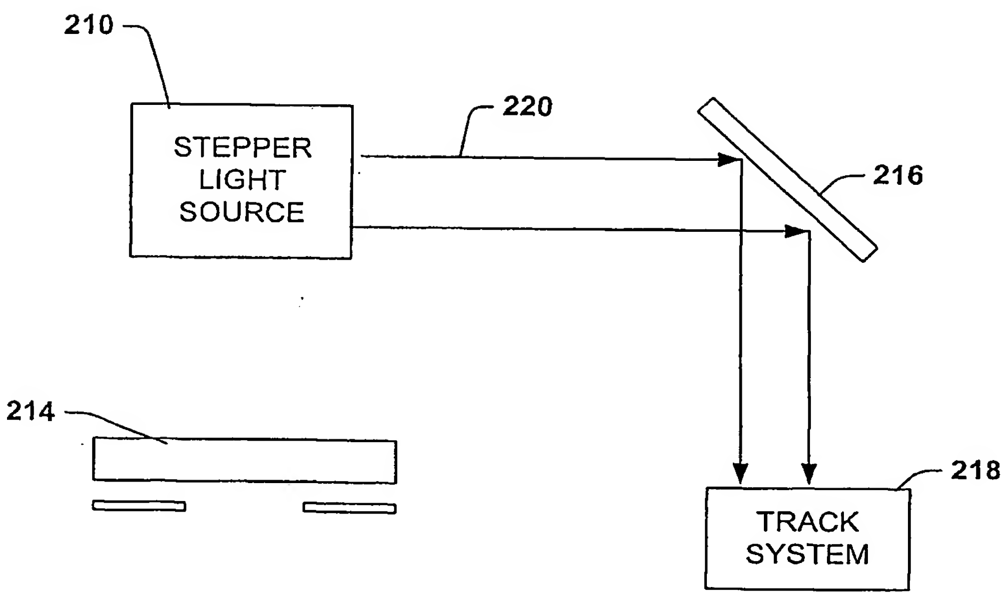
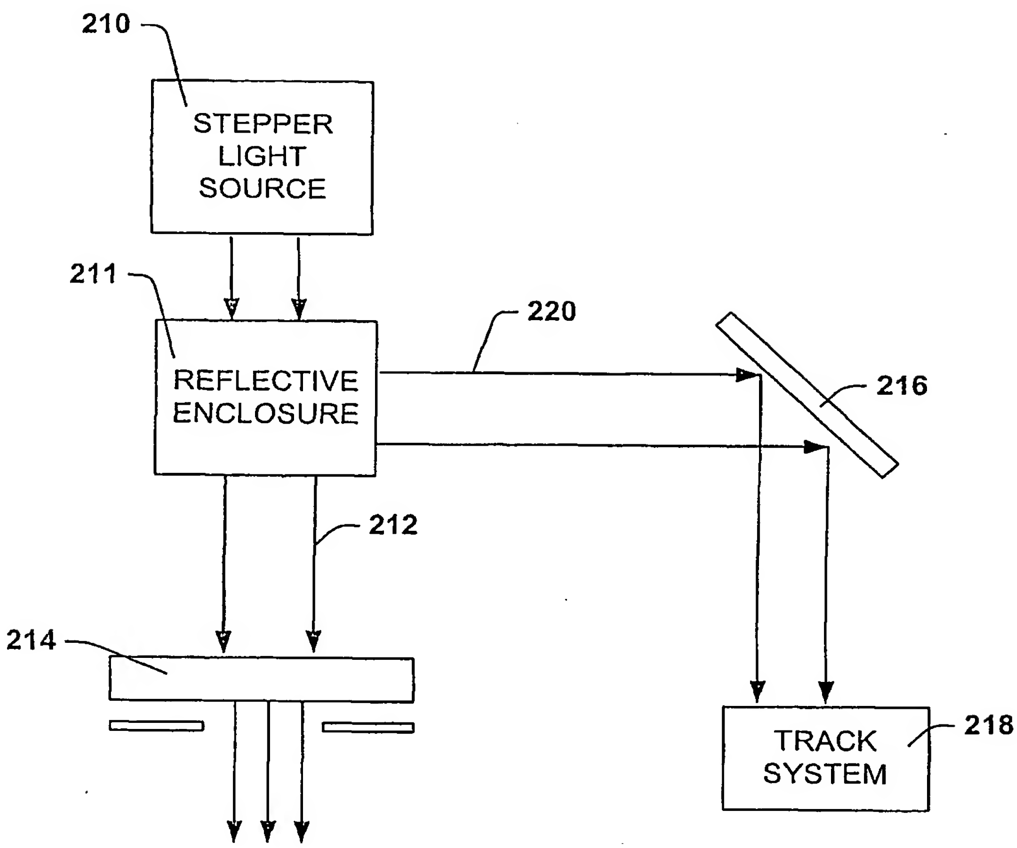

210
STEPPER
LIGHT
SOURCE
220
216
214
218
TRACK
SYSTEM

Fig. 6b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STEPPER LIGHT SOURCE
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REFLECTIVE ENCLOSURE
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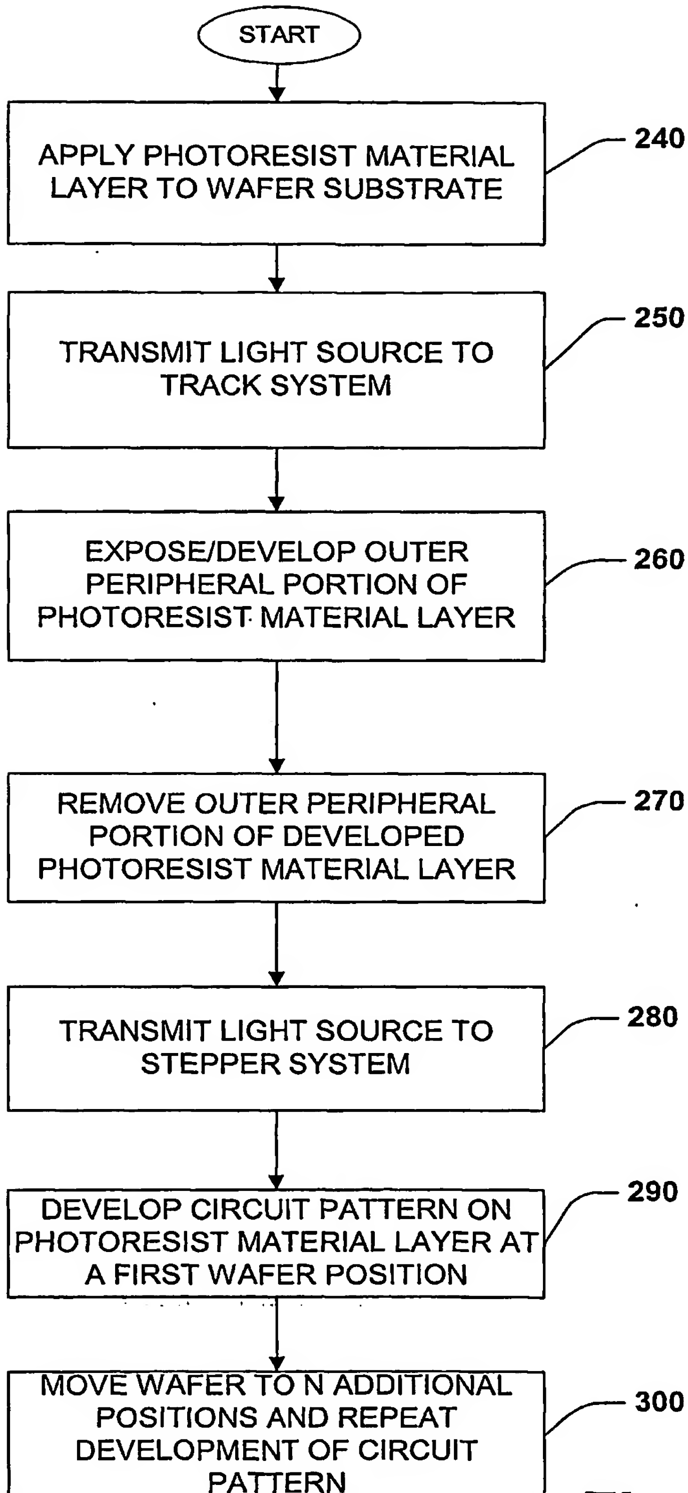
216
212
214
TRACK SYSTEM
218

Fig. 6c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APPLY PHOTORESIST MATERIAL LAYER TO WAFER SUBSTRATE
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TRANSMIT LIGHT SOURCE TO TRACK SYSTEM
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EXPOSE/DEVELOP OUTER PERIPHERAL PORTION OF PHOTORESIST MATERIAL LAYER
260
REMOVE OUTER PERIPHERAL PORTION OF DEVELOPED PHOTORESIST MATERIAL LAYER
270
TRANSMIT LIGHT SOURCE TO STEPPER SYSTEM
280
DEVELOP CIRCUIT PATTERN ON PHOTORESIST MATERIAL LAYER AT A FIRST WAFER POSITION
290
MOVE WAFER TO N ADDITIONAL POSITIONS AND REPEAT DEVELOPMENT OF CIRCUIT PATTERN
300

Fig. 7

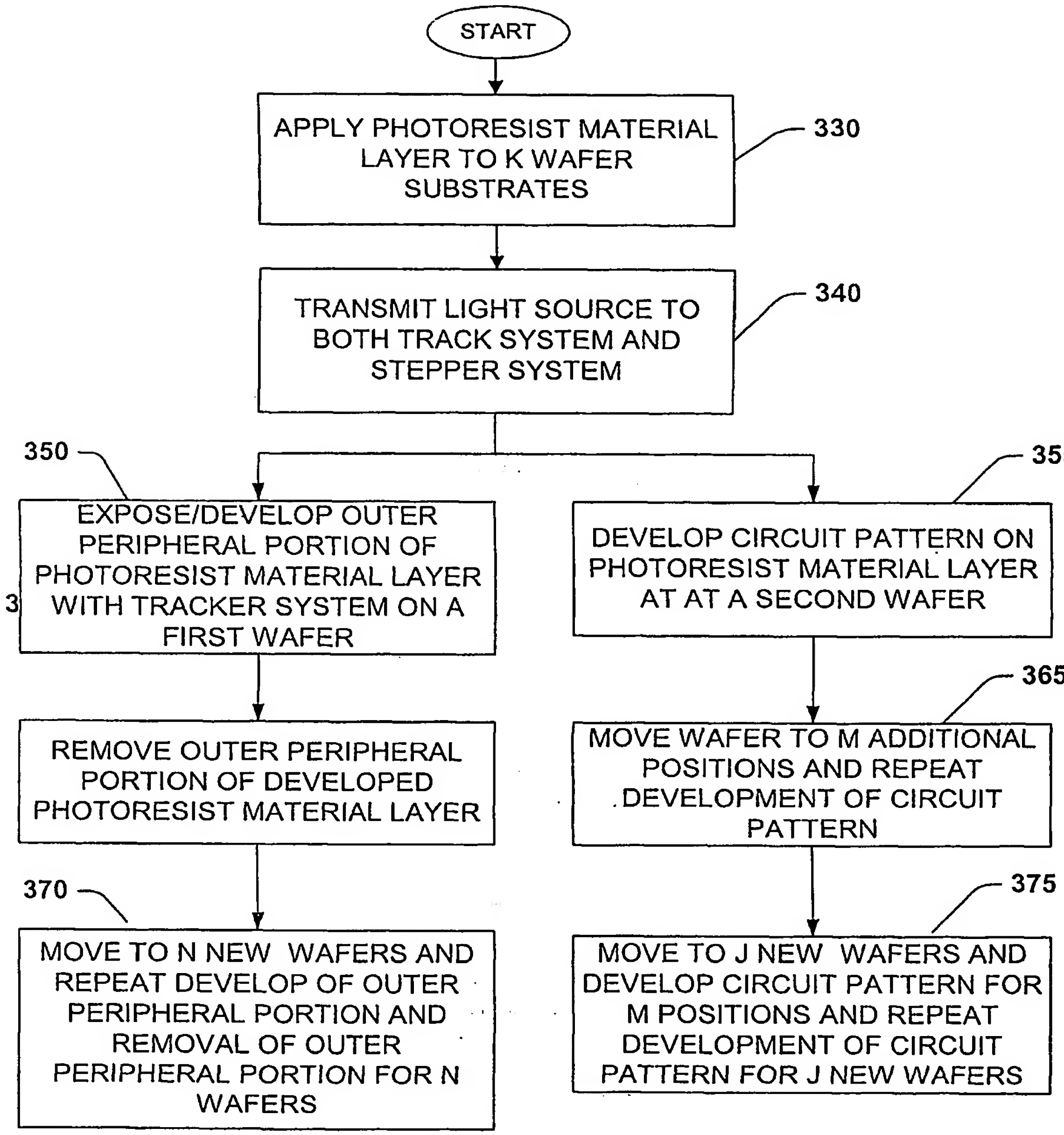
START
APPLY PHOTORESIST MATERIAL LAYER TO K WAFER SUBSTRATES
330
TRANSMIT LIGHT SOURCE TO BOTH TRACK SYSTEM AND STEPPER SYSTEM
340
350
EXPOSE/DEVELOP OUTER PERIPHERAL PORTION OF PHOTORESIST MATERIAL LAYER WITH TRACKER SYSTEM ON A FIRST WAFER
355
DEVELOP CIRCUIT PATTERN ON PHOTORESIST MATERIAL LAYER AT AT A SECOND WAFER
3
REMOVE OUTER PERIPHERAL PORTION OF DEVELOPED PHOTORESIST MATERIAL LAYER
365
MOVE WAFER TO M ADDITIONAL POSITIONS AND REPEAT DEVELOPMENT OF CIRCUIT PATTERN
370
MOVE TO N NEW WAFERS AND REPEAT DEVELOP OF OUTER PERIPHERAL PORTION AND REMOVAL OF OUTER PERIPHERAL PORTION FOR N WAFERS
375
MOVE TO J NEW WAFERS AND DEVELOP CIRCUIT PATTERN FOR M POSITIONS AND REPEAT DEVELOPMENT OF CIRCUIT PATTERN FOR J NEW WAFERS

Fig. 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/09509

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G03F7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 04, 30 April 1997 (1997-04-30) & JP 08 335545 A (HITACHI LTD), 17 December 1996 (1996-12-17) abstract; figure 1 ---	1,10
X	PATENT ABSTRACTS OF JAPAN vol. 015, no. 014 (E-1022), 11 January 1991 (1991-01-11) & JP 02 263426 A (CANON INC), 26 October 1990 (1990-10-26) abstract; figures ---	5,6,8

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
19 September 2001	26/09/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Aguilar, M.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/09509

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A		4
X	EP 0 788 032 A (USHIO ELECTRIC INC) 6 August 1997 (1997-08-06) column 16, line 6 -column 17, line 59 figure 14	1,5

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

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PCT/US 01/09509

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EP 0788032	A	06-08-1997	JP	9275073 A	21-10-1997
			DE	69702272 D1	20-07-2000
			DE	69702272 T2	21-12-2000
			EP	0788032 A1	06-08-1997
			US	5929976 A	27-07-1999